of the islands might be made highly remunerative. Sugar-cane, coffee, tea, cinchona, and cocoa are the principal staples advocated. Sugar is looked upon in a most favourable light; some parts of the islands, both in richness of soil and climate, as well as in extent, are spoken of as extremely favourable for growing and maturing the cane; so much so as to make all well-wishers of Fiji look for the time when sugar will be made in the islands and "exported by the hundred thousand tons and to the value of millions of pounds sterling." Regarding coffee we learn that the Government have sent large supplies of seed into the interior of Viti Levu to form coffee gardens for the natives. The plants are described as having an extremely healthy appearance. Tea and cinchona could both be grown successfully in Viti Levu over an extent of country roughly estimated at about one hundred square miles. Though many valuable timber trees exist in the islands it is suggested that several well-known Indian trees such as teak, saul, sissoo, toon, and ebony, as well as mahogany, rosewood, and others should be introduced. It is to be hoped that as the resources of Fiji, including those of the forests, become developed, no undue sacrifice of timber will be effected, but on the contrary the trees will be carefully preserved or replanted as others are cut down.

THE class of substances whose fluorescence does not follow Stokes's law, and so which do not emit rays of less refrangibility than the existing rays, has lately been enlarged by Prof. Lommel by addition of one of two new fluorescing substances. That is anthracene blue, an etheric solution of which fluoresces olive green very strongly; it is excited extremely weakly by the blue and the greater part of the violet rays, but very strongly by the orange-green and yellow-green. The second new fluorescing substance is bisulphobichloranthracenic acid, the etheric solution of which gives superficially a beautiful blue, and the interior a greenish fluorescence. It obeys Stokes's law.

THE French Minister of Public Works has not yet answered the inquiries made by M. Giffard as to the probability of the Cour de Tuileries being at his disposal up to the end of September, in order to organise a new series of captive ascents. But M. Giffard, willing to give the preference to his native city, has rejected the advantageous offers made by the German company offering to work his captive balloon, and to pay him a royalty of 33 per cent. on the gross receipts.

AT 12.35 A.M. on the 22nd inst. an earthquake traversed Northern Persia, taking a direction from Tabreez to Zendjan and Mianeh, and shocks continued with more or less severity until Sunday, the 23rd. Several strongly-built houses were thrown down at Mianeh, and in others large rents were made in the walls. The most serious damage, however, appears to have been occasioned in two villages off the road, about four farsachs from Mianeh, named respectively Tark and Manan. These were totally destroyed, and of the 500 inhabitants in the one case and the 600 inhabitants in the other, only a few are reported to have been saved. Mianeh is situated in north lat. 37° 27′, east long. 47° 43′.

IN a report from the Philippine Islands we learn that in the towns of Molo and Javo, both situated close to each other, and distant about three miles from Yloilo, it is very rare to enter a house that has not its loom at work, so large a trade is done in weaving not only in the towns themselves but all over the province. The principal fibre used is that of the pine-apple, and some of the articles manufactured, such as shirts and dresses, are of considerable merit and sell at high prices. In weaving China silk in colours is intermixed with the pine-apple fibre, for the purpose of giving stripes to the dresses and shirts. The value of the Chinese silk so imported varies at from 200,000 dol. to 400,000 dol. (£40,000 to £80,000) per annum.

THE Teplitz thermal question may be considered as being solved in the most satisfactory manner. The Spring Committee established by the Austrian Government declared that the quantity of recovered water is 2,224 cubic feet per hour, which is sufficient for supplying all the thermal establishments in existence before the catastrophe. The temperature has not been altered in any sensible manner. It appears that altogether the catastrophe may be considered as having been in some respects useful. The actual quantity is one-third more than the sum of the several sources which were used before the catastrophe.

WE have received the first number of a new American journal —*Useful Arts*—edited by Mr. J. A. Whitney. It contains a great deal of miscellaneous industrial information, mostly referring to patents.

Gardening Illustrated is the title of a new cheap "weekly journal for town and country."

A METEOROLOGICAL work, entitled "Ergebnisse fünfzigjähriger Beobachtungen der Witterung zu Dresden," with an introduction on meteorology, the atmosphere, meteorological instruments and observations, has just been published by Dr. Adolf Drechsler, the director of the Royal Physico-Mathematical Institution at Dresden.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by Miss Sandford; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. George Eggar; a Chinchilla (*Chinchilla lanigera*) from South America, presented by Sir Chas. Smith; a Greater-spotted Woodpecker (*Picus major*) European, presented by Mr. H. Laver; a Sumatran Rhinoceros (*Rhinoceros sumatrensis*) from Sumatra, a Tabuan Parrakeet (*Pyrrhulopsis tabuensis*), a Stair's Dove (*Phlogœnas stairi*) from the Fiji Islands, deposited; a Pied Wagtail (*Motacilla yarrelli*), a Reed Bunting (*Emberiza schœniclus*) European, purchased.

SPECULATIONS ON THE SOURCE OF METEORITES[1]

I HAVE recently read M. G. Tschermak's most interesting memoir, "Die Bildung der Meteoriten und der Vulcanismus."[2] I am not competent to offer any opinion on the mineralogical questions involved in his discussion, but the numerous arguments he has adduced appear to me to justify his conclusion that "the meteorites have had a volcanic source on some celestial body." These arguments are briefly as follows:—

Meteorites are always angular fragments even before they come into the air.

Most meteoric irons have a crystalline structure which, according to Haidinger, requires a very long period of formation at a nearly constant temperature. This condition could only have been fulfilled in a large mass.

Many meteoric stones show flutings resembling those seen on terrestrial rocks and which are due to the rubbing of adjacent masses.

Other meteoric stones show a joining together of several fragments analogous to breccia.

Many meteoric stones are composed of very small particles analogous to volcanic tufas.

After glancing at the old theory of the volcanoes in the moon and rejecting as untenable the supposition that meteorites have any connection with ordinary shooting stars, Tschermak concludes—"We may suppose that many celestial bodies of considerable dimensions are still small enough to admit of the possibility that projectiles driven from them in volcanoes shall not return by gravity. These would really be the sources of meteorites." Similar views having been put forward by Mr. J. Lawrence Smith and other authorities it is not unreasonable to discuss the following problem.

[1] Read at the Royal Irish Academy, January 13.

[2] "Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften," Wien, 1875. Band lxxi., Abtheilung 2, pp. 661–674.

If meteorites have been projected from volcanoes, on what body or bodies in the universe must those volcanoes have been located?

Let us first take up a few of the principal celestial bodies *seriatim* and consider their claims to the parentage of the meteorites. We begin with the sun. It has been abundantly shown that there exists upon the sun tremendous explosive energy. It is not at all unlikely that that energy would be sufficiently great under certain circumstances actually to drive a body from the sun never to return. We might therefore find upon the sun adequate explosive power for the volcano, but the projectiles are here the difficulty. There are a number of circumstances (notably the breccia-like appearance of some meteorites) which show conclusively that the meteorites have been torn from rocks which were already nearly, if not quite, solid, and as it seems in the highest degree improbable that rocks of this nature should exist in the sun, we may conclude that the sun has not been the source of the meteorites.

Can the meteorites have come from the moon? Owing to the small mass of the moon the explosive energy required to carry a body away from the moon is comparatively small. Can such a body fall upon the earth? *To simplify questions of this kind we shall suppose various disturbing influences absent.* We shall suppose that the projectile is discharged from a volcano on the moon with sufficient velocity to carry it therefrom. We shall then omit all account of the disturbing influence both of the sun and moon on the projectile, and we shall suppose that the projectile is really revolving round the earth as a satellite. This projectile will fall upon the earth if its distance from the earth's centre when in perigee be less than the radius of the earth (augmented, perhaps, by the thickness of the earth's atmosphere). It should however be observed that *if the projectile once escaped the earth it would never fall thereon,* hence the question as to whether the moon can be the source of the meteorites now falling appears to be connected with the question as to whether the lunar volcanoes are *now* active. But it is generally believed that the lunar volcanoes are not now active to any appreciable extent (even if the suspected indications of recent change were thoroughly established). It follows that even if the moon has been a source of meteorites in ancient times, we no longer receive a supply from that quarter. There is of course just a possibility that projectiles from the moon which have been revolving round the earth as satellites in elliptic orbits ever since their ejection may, under the influence of *the disturbing causes previously excepted,* gradually change their orbits until they become entangled in the atmosphere and descend as meteorites. It therefore appears to be not quite impossible that even still a meteorite which had its origin in the moon in past ages may occasionally tumble on the earth.

Passing from the sun and the moon let us now bring under review some of the other celestial bodies and see how far they will fulfil the conditions of the question. Is it possible that the meteorites can have been projected from the surface of a planet? In order to get over the difficulties of the great initial velocity which would be necessary to overcome the gravitation of a large planet, it seems natural to inquire if a volcano placed upon one of the small planets could accomplish the task.

It is clearly impossible that a projectile should ever fall on the earth unless the orbit of the projectile cuts the plane of the ecliptic in a point which lies in the narrow ring between 8,000 and 9,000 miles wide which the earth traces out on the ecliptic, but if a meteorite with an elliptic orbit intersect this ring, then, in the lapse of time, it may happen that the earth and the meteorite meet at the intersection of their orbits, in which case of course the long travels of the meteorite will come to an end.

We shall therefore consider the circumstances under which it would be possible to discharge a projectile from the surface of a planet (say Ceres), so that the projectile shall intersect the ecliptic in the ring we have just referred to. The planet being small the initial velocity that would be required to carry a projectile from its surface presents no difficulty; perhaps an ordinary cannon would be sufficient *so far as the mere gravitation to the planet is concerned.* But when we consider the necessity that the projectile must be driven through the ring we have been considering, a vastly more powerful instrument would be required.

Ceres is moving in an orbit (supposed circular and in the ecliptic) with a velocity of about eleven miles per second. A projectile discharged from Ceres will have an actual velocity which is compounded of the velocity of Ceres, with the velocity which is imparted by the volcano. But simple dynamical considerations show that if the projectile have an initial velocity *perpendicular to the radius vector,* differing from about eight miles per second, it can never intersect the ring, no matter in what direction it be discharged.[1] The volcano on Ceres must therefore be adequate to the abatement of the velocity perpendicular to the radius vector from eleven miles per second to eight miles per second, *i.e., the volcano must be at the very least adequate to producing an initial velocity of three miles per second.* As this is quite independent of the additional volcanic power requisite to carry the projectile away from the attraction of Ceres, it is obvious that after all there may be but little difference between the volcano which would be required on Ceres, and that (of six mile power) which would project a body away from the surface of the earth for ever.

Admitting, however, that a volcano of sufficient power were placed upon Ceres, would it be likely that a projectile driven therefrom would ever cross the earth's track? This is a question in the theory of probabilities, and it is not easy to state the problem very definitely. If the *total* velocity with which the projectile leaves the orbit of Ceres be less than eight miles per second, then the projectile will fall short of the earth's track; on the other hand, if the *total* initial velocity exceeds sixteen miles per second, the orbit in which the projectile moves will be hyperbolic, and though it may cross the earth's track once, it will never do so again. Taking a mean between these extreme velocities we may investigate the following problem:— Suppose that a projectile is discharged from a point in the orbit of Ceres in a *random* direction with the *total* initial velocity of twelve miles per second, determine the probability that the orbit of the projectile shall cross the earth's track. When this problem is solved in accordance with the calculus of probabilities it is found that the chances against the occurrence are about 50,000 to 1, *i.e.*, out of every 50,000 projectiles discharged at random from a point in the orbit of Ceres, only a single one can be expected to cross the earth's track.

It is thus evident that there are two objections to Ceres (and the same may be said of the other minor planets) as a possible source of the meteorites. Firstly, that notwithstanding the small mass of Ceres, a very powerful volcano would be required; and secondly, that we are obliged to assume that for each meteorite which could ever fall upon the earth, at least 50,000 must have been ejected.

It thus appears that if the meteorites have been originally driven from any planet of the solar system, large or small, the volcano must from one cause or another be a very powerful one.

There is, however, one planet of the solar system which has a special claim to consideration. On that planet it is true that a volcano would be required which was capable of giving an initial velocity of at least six miles per second; but *every* projectile launched from that volcano into space would, after accomplishing an elliptic orbit round the sun, dash through the track of the earth, and again pass through the same point at every subsequent revolution. It is not here a case of one solitary projectile out of 50,000 crossing the earth's track, but every one of the 50,000 possesses the same property. The planet of which we are speaking is, of course, the earth itself. If in ancient times there were colossal volcanoes on the surface of the earth which had sufficient explosive energy to drive missiles upwards with a velocity sufficient to carry them away from the earth's surface, after making allowance for the resistance of the air, these missiles would then continue to move in *orbits round the sun,* crossing at each revolution the point of the earth's track from which they were originally discharged. If this were the case, then doubtless there are now myriads of these projectiles moving through the solar system, the only common feature of their orbits being that they all intersect the earth's track. It will, of course, now and then happen that the earth and the projectile meet at the point of crossing, and then we have the phenomenon of the descent of a meteorite. This theory, that the meteorites have originated in the earth, was so far as I know first put forward by Dr. Phipson. Mr. J. Lawrence Smith in a letter I received from him some months ago inclines to the same view as at all events one of the probable sources.

It is well to note here the great difference between the lunar theory of meteorites and the terrestrial theory. For the lunar theory to be true it would probably be necessary that the lunar volcanoes should be *still* active. In the terrestrial theory it is only necessary to suppose that the volcanoes on the earth *once*

[1] Disregarding an obvious exception.

possessed sufficient explosive energy. No one supposes that the volcanoes on the earth at present eject the fragments which will constitute future meteorites, but it seems probable that the earth may be now slowly gathering back in these quiet times the fragments she ejected *in an early stage of her history*.

Assuming, therefore, that the meteorites have had a quasi-volcanic origin on some considerable celestial body, I am led to agree with those who believe that most probably that body is the earth. ROBERT S. BALL

RECENT RESEARCHES ON ABSORPTION SPECTRA

THE numerous absorption spectra of soluble substances which have been described hitherto, have referred as a rule to the solutions of the substances, and but rarely to the solid substances themselves. It is true that certain differences were remarked between the spectra of certain solutions, those of uranium and didymium salts, for instance, and the spectra of the solid salts; yet, on the whole, these differences were so slight that it was generally believed that the spectra were essentially the same. On the other hand experiments had shown that the spectra of solutions differed according to the dissolving medium; indeed Herr Kundt established the fact that the absorption band of a substance in solution lies the nearer to the red end of the spectrum the stronger the dispersion of the dissolving medium. In these experiments the fact seems to have been overlooked that when changing the dissolving medium often the whole character of the spectrum is changed, so that comparison with the former one becomes extremely difficult. Close investigation of these differences was therefore an important desideratum, both for the theory of absorption spectra as well as for practical absorption spectrum analysis.

In the Monthly Report of the Berlin Academy of Sciences, Herr Vogel has recently published the results of such investigations, to which he was led by the remarkable differences between the spectra of solid and those of dissolved substances which he had observed in the case of certain pigments.

For the examination of these absorption spectra Herr Vogel used instruments of but moderate dispersion, which allow of an easier survey of the whole spectrum, and consequent judgment of its general character, than is the case with strongly dispersing spectroscopes. The absorption spectra of solid salts and pigments were obtained from thin layers of these substances, prepared upon glass plates, through evaporation of a few drops of solution. Herr Vogel reproduces the spectra he observed on two plates, which at once show not only *the differences in the spectra of one and the same solid substance and its solution*, but frequently an *extraordinary coincidence in the position of the absorption bands belonging to totally different substances* (for instance, in nitrate of uranium and permanganate of potash). Of several substances, such as iodine, hyponitric acid, and indigo, the spectrum of the vapour is also given for comparison, and in most cases the aqueous, alcoholic, and some other solution of each substance has been examined.

Without entering into the highly interesting details for which we must refer our readers to the original paper, we confine ourselves to stating the results of Herr Vogel's researches, which are the following: 1. Considerable differences exist between the spectra which a substance gives in the solid, liquid, or dissolved and gaseous state. Characteristic bands which are shown in the spectrum of one state are either not reproduced in that of the other (this is the case with chrome alum, chloride of cobalt, iodine, bromine, naphtaline red, fuchsine, indigo, cyanine, aniline blue, methyl violet, eosine, carmine, purpurine, alizarine, santaline), or they reappear in a different position, or different intensity (examples: nitrate of uranium, permanganate of potash, hyponitric acid, alcanna red). Sulphate of copper and chlorophyll show the same absorption both in the dissolved and in the solid state.

2. The spectra given by the same substance when dissolved in different media are the same in some cases (purpurine in alcohol or sulphide of carbon, aldehyde green in water or alcohol, methyl violet and indigo-sulphuric acid in water or amylic alcohol); in other cases they differ only in the position of bands (chloride of cobalt, fuchsine, coralline, eosine and iodine green in aqueous or alcoholic solutions); and again in others their character is totally different, so that no point of coincidence remains (iodine in sulphide of carbon or alcohol, naphtaline, aniline blue, purpurine, hæmatoxyline, brasiline in water or alcohol).

3. The rule established by Kundt, viz., that the absorption bands of a body in solution lie the nearer towards the red end of the spectrum the greater the dispersion of the dissolving medium is in the region of the bands, is not confirmed in many cases; on the contrary, in some instances the absorption bands move towards the blue in a solution of greater dispersion (nitrate of uranium and blue chloride of cobalt in water and alcohol); in other cases their position remains unaltered for various media (hyponitric acid in air and benzol, indigo-sulphuric acid and methyl violet in water and amylic alcohol, aldehyde green in water and alcohol, purpurine in sulphide of carbon and alcohol). In some cases a great difference in the sense of Kundt's rule becomes apparent, while in others for the same spectral region but a very trifling one appears, according to the nature of the pigment (coralline and fuchsine). Indeed it happens sometimes that certain bands are in the same position with different dissolving media, while others which are *simultaneously* visible are displaced (nitrate of uranium in water and alcohol, oxide of cobalt in glass and in water, protonitrate of uranium in neutral solution and in a solution of oxalic acid, chlorophyll in alcohol and ether).

4. The position of absorption bands in the spectra of solid and dissolved bodies may be only exceptionally deemed characteristic for any certain body. Totally different bodies show absorption bands in exactly the same position (solid nitrate of uranium and permanganate of potash in the blue; naphtaline red and coralline in the yellow; indigo, aniline blue, and cyanine in the orange; aldehyde green and malachite green in the orange). Closely related substances sometimes show remarkable differences in the position of their bands under prefectly equal conditions (solid uranium salts).

5. The rule set up for absorption spectra, "each body has its own spectrum," can be admitted only with great restrictions. The great number of polychromatic substances show different colours and different spectra in the solid state, according to the direction in which they are observed. Most other bodies show different spectra in the solid state from those of their solutions, and in the latter case again different ones according to the dissolving medium, and the question arises which of all these spectra is the body's "*own*" spectrum.

The most important difference of the spectra of elements in a state of incandescent vapour, the position of the spectral lines, ceases to be characteristic in the case of absorption spectra of liquid and solid bodies. In the latter spectra, however, the characteristic differences shown by the spectra of incandescent vapours cannot be expected. It is known that metals, which give such remarkably different spectra in the state of incandescent vapours, all give qualitatively the same spectrum as incandescent liquids or solids, viz., a continuous one; for this reason the absorption spectra of these bodies cannot show any remarkable characteristic differences, whatever quantitative differences may become apparent with regard to the absorbed colours. If these well-known facts show that already with regard to elements the laws applying to the spectra of gases do not apply to those of liquids and solids, then Herr Vogel's investigations prove that in the case of compound bodies simple relations between the spectra of their different aggregate states are still less frequent and occur only exceptionally.

The analysis of absorption spectra therefore is based not so much upon the recognition of the position of the absorption bands of a substance, as upon the *changes in the spectra* of the same body which take place under the influence of various dissolving media and reagents. Thus cyanine and aniline blue dissolved in alcohol give a very similar spectrum, dissolved in water a totally different one. The absorption bands of oxyhæmoglobine disappear with reducing agents; those of carmine, which are in a similar position, do not; the band of brasiline disappears when acetic acid is added to the solution, that of fuchsine does not, &c., &c.

The position of bands becomes more characteristic for the recognition of a body, if the latter shows *several* absorption bands. But even here we should go too far if from the accidental coincidence in the position of bands of two different bodies we were to draw conclusions regarding any similarity or chemical identity between them (this has indeed been done in certain cases, particularly with blood and chlorophyll). A conclusion regarding such similarity or identity is only justified if *the same bands show equal intensities and analogous changes under the influence of the same reagents.*